

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

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First Named Inventor or Application Identifier Christopher J. Lord

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APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☒ Fee Transmittal Form
(Submit an original, and a duplicate for fee processing)
2. ☒ Specification (Total Pages 20)
(preferred arrangement set forth below)
 - Descriptive Title of the Invention
 - Cross References to Related Applications
 - Statement Regarding Fed sponsored R & D
 - Reference to Microfiche Appendix
 - Background of the Invention
 - Brief Summary of the Invention
 - Brief Description of the Drawings (if filed)
 - Detailed Description
 - Claims
 - Abstract of the Disclosure
3. ☒ Drawings(s) (35 USC 113) (Total Sheets 6)
4. ☒ Oath or Declaration (Total Pages 4)
 - a. ☒ Newly Executed (Original or Copy)
 - b. ☐ Copy from a Prior Application (37 CFR 1.63(d))
(for Continuation/Divisional with Box 17 completed) (Note Box 5 below)
 - i. ☐ DELETIONS OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
5. ☐ Incorporation By Reference (useable if Box 4b is checked)
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. ☐ Microfiche Computer Program (Appendix)
7. ☐ Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)
 - a. ☐ Computer Readable Copy
 - b. ☐ Paper Copy (identical to computer copy)
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ACCOMPANYING APPLICATION PARTS

8. ☒ Assignment Papers (cover sheet & documents(s))
9. ☐ a. 37 CFR 3.73(b) Statement (where there is an assignee)
☐ b. Power of Attorney
10. ☐ English Translation Document (if applicable)
11. ☐ a. Information Disclosure Statement (IDS)/PTO-1449
☐ b. Copies of IDS Citations
12. ☐ Preliminary Amendment
13. ☒ Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
14. ☐ a. Small Entity Statement(s)
☐ b. Statement filed in prior application, Status still proper and desired
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

TITLE OF THE INVENTION

**VIDEO BIT STREAM EXTENSION WITH SUPPLEMENTARY CONTENT INFORMATION
TO AID IN SUBSEQUENT VIDEO PROCESSING**

INVENTORS

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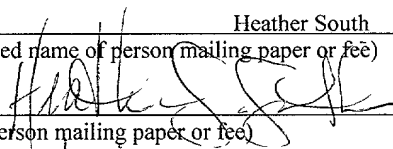
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**VIDEO BIT STREAM EXTENSION WITH SUPPLEMENTARY CONTENT INFORMATION
TO AID IN SUBSEQUENT VIDEO PROCESSING**

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BACKGROUND OF THE INVENTION

(1) Field of the Invention

The present invention is related to the field of video processing, and more specifically, to the method and apparatus of video bit stream extension to aid in subsequent video processing.

15

(2) Related Art

Currently, the motion picture and television industries utilize various video processing methods and apparatus to create special effects to captured video. Typically, video images are captured by some type of a video capture device, and recorded on a storage device. One or more video sequences from one or more video sources, such as a storage device, may be analyzed to collect information regarding each video sequence. The collected information is then utilized to manipulate the video sequence through, for example, some type of computer system, to create special effects. For example, video sequences from two different sources may be merged by video compositing to create

20

special effects. In order to perform video compositing, information regarding each video sequence may be useful.

It is therefore desirable to provide a method and apparatus to generate an extended video bit stream for a video sequence. The desired extended video bit stream would
5 contain non-visual information useful in several applications including but not limited to motion picture and television special effects, post processing, video editing and video library management.

BRIEF SUMMARY OF THE INVENTION

A method for annotating video and audio media with supplementary content for post video processing is disclosed. The method includes the steps of accepting video data from a video source and storing video information associated with the video data as the video data is being accepted. Then, the video information may be appended to the video data for later use in the form of annotations, for example.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1a is an exemplary system block diagram of a video source and video output video processing system according to one embodiment of the present invention.

5 **Figure 1b** illustrates a video processing information collection and annotation system according to one embodiment of the present invention.

10 **Figure 2** is a block diagram illustrating calibration software configured to determine camera geometry information from each frame and/or scene data of a video sequence made available through a video source device according to one embodiment of the present invention.

15 **Figure 3** is a block diagram of pose estimation software configured to determine camera pose information for each frame and/or scene data collected from a video source device according to one embodiment of the present invention.

20 **Figure 4** is a block diagram of illumination input software which is configured to accept illumination information for a given frame or scene data of a video sequence provided through a video source device according to one embodiment of the present invention.

25 **Figures 5a-5c** illustrate an annotated video extended bit stream format according to one embodiment of the present invention.

30 **Figure 6** is a flow diagram illustrating the general steps followed by annotator software configured to annotate a video bit stream with certain video processing information according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a method and apparatus for producing an annotated video extended bit stream to aid video processing. In one embodiment of the present invention, certain video sequence information is collected on a per frame, per
5 video segment or a per scene basis, as video data is being provided through a video source device. Video information is added to a video bit stream to generate an extended video bit stream with annotations (hereinafter referred to as an annotated video extended bit stream).

The annotated video extended bit stream of the present invention includes both
10 the original video sequence as well as certain additional non-visual information. The additional non-visual information is useful in subsequent processing of the video data provided by a video source device for several applications including special effect processing, easy access to video databases, efficient video coding, and easier generation of three-dimensional models.

15 Prior art methods must rediscover the information which the present invention annotates by using only the available visual data. Further, the present invention solves mathematically ill posed problems for which solutions are not available. Additionally, the present invention efficiently provides access to data for which solutions are possible, but are obtained through great computational cost. The present invention leads to better
20 and faster compression via model building than prior art methods which rediscover the factors from the captured media only.

Additionally, the present invention allows better digital manipulation of media. For example, three-dimensional models of objects in a scene can be constructed and used as search keys in a video database, and geometric and photometric properties can be used

as derived search keys. Camera scene content is already often under program control. This control information as well as what can be sensed in the camera, such as a cameraman turning a zoom lens and camera pose, is conveyed to subsequent processing software through the annotated video extended bit stream of the present invention.

5 Although the present invention is described for use in the motion picture and television industries, the present invention may also be useful in video cameras used by consumers to automatically or manually annotate certain parameters set during recording, such as zoom factor or focus.

Figure 1a is an exemplary system block diagram illustrating a video source and
10 video output system according to one embodiment of the present invention. In this example, the video processing information collection and annotation system 104 may be implemented for use on a computer 102 with some type of a storage device 103 coupled to a processor 105 by bus 107. The computer 102 may be coupled to a video source 100 configured to provide video data (video sequence) to the computer 102. In one
15 embodiment, the video source 100 may be, but is not limited to, a video capture device 106 such as a camera, a video replay device 108 such as a video camera recorder (VCR) and a video transmission device 110 such as a digital or an analog television (TV).

 The present invention's video processing information collection and annotation
20 system 104 collects certain video processing information from video image data (frame or scene) as they are provided from the video source 100 and generates an annotated video extended bit stream comprised of the video image data as well as corresponding video processing information.

 Although the video processing information collection and annotation system 104 is illustrated as being implemented in a computer 102, a person skilled in the art provided

with the detailed description herein may appreciate that the video processing information collection and annotation system 104 may also be implemented in the video source 100 such as a camera.

Figure 1b illustrates a video processing information collection and annotation system 104 according to one embodiment of the present invention. Video data 200 is provided by video source 100 in the form of frames (scenes) and forwarded to a collector 201. A calibration software 206, such as NCAMERA from REALVIZ of Sophia Antipolis Cedex, France, generates camera geometry information 204. The camera geometry information 204 may be generated either from the video data 200 provided by the video source 100 or as the video data is being captured by a video capture device 106. The camera geometry information 204 is then forwarded the information on to the collector 201. Similarly, a pose estimation software 210, such as MATCHMOVER from REALVIZ of Sophia Antipolis Cedex, France, generates camera pose information 208. The camera pose information 208 may be generated from the video data 200 provided by the video source 100 or at the same time that the video data 200 is being captured by a video capture device 106. The camera pose information 208 is then forwarded to the collector 201.

Source identification/description and illumination information is gathered by a source identification/description/illumination input software 212 from, for example, input by a camera operator (user) or a television director operating a television switcher (not shown). The information gathering may be fully automated by the television switcher. The gathered source identification/description/illumination information 211 is then forwarded along with the camera geometry information 204 and the camera pose information 208 to the collector 201. The collector 201 forwards the information collected to an annotator 202.

The current state of the frame data and the gathered information are received and compared by a comparator 222. The gathered information and current state are also received by a differential generator 230 which determines the differential information.

More specifically, the auxiliary information is gathered periodically but only encoded in the bit stream if there are changes. The current state indicates the latest encoded information in the bit stream and is kept in memory, e.g., state storage 240. The differential information is the difference between the current information and the gathered information. If the information remains the same, there is no need to annotate the bit stream.

The differential information is encoded by an encoder 224 as auxiliary information for the current frame data. The annotator 202 stores the various information gathered in the video bit stream 200 by extending the original bit stream format. The annotated video extended bit stream 214 may be utilized by a video processor 216 to separate video data 218 from auxiliary information 220. The video data 218 is equivalent to video data 200 before processing by the annotator 202 and the auxiliary information 220 is additional information gathered regarding the video data 200 including the camera geometry information 204, the camera pose information 208 and the source identification/description/illumination information 211.

Figure 2 is a block diagram illustrating the gathering of calibration information according to one embodiment of the present invention. In this example, camera geometry (intrinsic parameters) is provided by a camera calibration procedure which provides a camera projection matrix 270. In one embodiment, instrumentation attached to a set of actuators 250 is used to control and keep track of the geometry of cameras (e.g., auto-focus). Calibration is obtained by using a calibration box 260 of known size and shape

with a distinct set of markers on its surface. The calibration software 206 utilizes the calibration box 260 to produce the camera projection matrix 270.

More specifically, in one embodiment, a video capture device 106 such as a camera causes a transformation to the incumbent light. This transformation depends on the physical arrangement of lenses and light sensors of the video capture device that is modeled by a 3 x 4 transformation matrix also referred herein as a camera projection matrix 270. The twelve parameters from the projection matrix define the camera geometry. Various methods for producing the projection matrix 270 are well known.

Figure 3 is a block diagram illustrating the gathering of camera pose estimation information according to one embodiment of the present invention. The camera pose information 208 includes extrinsic camera parameters. More specifically, the images generated by a video capture device such as a camera depends on the position of the video capture device 106. The six degrees of freedom of camera pose may be defined with respect to a given reference. For example, the position of the camera on the very first frame may be used as a reference from which the camera pose for the subsequent frames may be measured.

Computation of the pose estimation information 208 may be made by the pose estimation software 210. Depth maps are estimated from a video sequence by using structure from motion. For example, the registration of the depth map to a three-dimensional model of the scene provides the pose information. The three-dimensional scene model may be constructed using the registered data in one embodiment. Obtaining pose estimation from video data is well known in the art and needs no further discussion.

Alternatively, camera pose may be provided by a position tracking system based on gyroscopes, pendulums or magnetic field sensors (similar to those used in virtual

reality helmets) installed in a video capture device 106 and provided to the collector 2d by the video capture device 106. Instrumentation attached to a set of actuators 250 (attached to the video capture device 106) may be used to remotely control the pose of robotic cameras remotely.

5 **Figure 4** is a block diagram illustrating the gathering of source identification/description and illumination information according to one embodiment of the present invention. Video source identification and description is provided by using information which is available either at a television (TV) switcher (live production) or editing A/B roll machine (off-line production). A TV director/editor defines an editing
10 list which is implemented by an operator controlling the TV switcher 400 or A/B roll machine.

All cameras and video sources are logged before actual editing. For future movies, this process is performed at the story board. Story board drawings and text have a one-to-one correspondence to video shoots. Individual shoot description may be
15 annotated with the final video at production time.

Video source identification 402, which is part of the source identification/description/illumination information 211 delineates one parameter which defines a source number. More specifically, production video typically is composed from multiple video sources 106 where each clip may be identified at production time. Each
20 clip has an associated parameter which defines a source number for the clip.

The video source description 405 of the source identification/description/illumination information 211 refers to textual descriptions for distinct video sources. For instance, TV directors typically have textual descriptions for distinct video sources, such as for a National Basketball Association (NBA) game.

"Scoreboard shoot", "court overview", "action on court", "close-up on coach", or "close-up of commentator" are different source descriptions.

Finally, the illumination condition 403, also part of the source identification/description/illumination information 211, refers to computer controlled sets and lighting system 404. The controls may be annotated as part of the scene description as well. For insertion of computer-generated actors in a scene, lighting information is fundamental on a per-frame basis.

Figures 5a – 5c illustrate an exemplary annotated video extended bit stream format according to one embodiment of the present invention. The exemplary annotated video extended bit stream 500 illustrated in **Figure 5a** has ancillary information 502 which is a list of parameters of arbitrary length. The parameters are described in more detail in a corresponding entry in a tag lookup table 503 illustrated in **Figure 5c**. In one embodiment, the tag lookup table 503 resides in storage device 103. The parameters having the information described in **Figures 2, 3 and 4** are valid until a new setting appears in the annotated video extended bit stream 500.

Figure 6 is a flow diagram illustrating the general steps followed by annotator software configured to annotate a video bit stream with certain video processing information according to one embodiment of the present invention. In step 601, frame data is obtained from a video source. In step 602, information regarding the frame data, including camera geometry 204, camera pose 208 and source identification description illumination software 211 is gathered. In step 603, gathered information is stored in a state storage device. In step 604, the current state of the frame data and the gathered information is compared by a comparator 222.

In step 605, differential information is generated according to the results of the comparison. More specifically, the auxiliary information is gathered periodically but only encoded in the bit stream if there are changes. The current state indicates the latest encoded information in the bit stream and is kept in memory. The differential

5 information is the difference between the current information and the gathered information. If the information remains the same, there is no need to annotate the bit stream.

In step 606, the differential information is encoded by an encoder 224 as auxiliary information for the current frame data. In step 607, the auxiliary information is annotated

10 to the encoded frame data to generate an annotated video extended bit stream 214.

What has been described is a method and apparatus for annotating video and audio media with supplementary content for subsequent video processing. Prior art methods must rediscover the information which the present invention annotates by using only the available visual data. The present invention solves mathematically ill posed

15 problems for which solutions are not available. Additionally, the present invention efficiently provides access to data for which solutions are possible, but are obtained through great computational cost. The present invention leads to better and faster compression via model building than prior art methods which rediscover the factors from the captured media only.

20 While certain exemplary embodiments have been described in detail and shown in the accompanying drawings, it is to be understood that such embodiments are merely illustrative of and not restrictive on the broad invention, and that this invention is not to be limited to the specific arrangements and constructions shown and described, since various other modifications may occur to those with ordinary skill in the art.

CLAIMS

What is claimed is:

1 1. A method of processing video data comprising the steps of:
2 accepting video data from a video source; and
3 storing video information associated with the video data as the video data is being
4 accepted, the video information being stored as annotations to the video data.

1 2. The method of claim 1, wherein the video information comprises camera
2 geometry information.

1 3. The method of claim 1, wherein the video information comprises camera
2 pose information.

1 4. The method of claim 1, wherein the video information comprises source
2 identification/description/illumination information.

1 5. The method of claim 1, wherein the video data comprises frame data
2 obtained from an encoder.

1 6 The method of claim 1, wherein the video source comprises a video
2 capture device.

1 7. The method of claim 5, further comprising gathering a current state of the
2 frame data.

1 8. The method of claim 7, further comprising comparing the current state
2 with the camera geometry information, the camera pose information and the source
3 identification/description/illumination information of the frame data.

1 9. The method of claim 8, further comprising determining differential
2 information from a result of the comparing step.

1 10. The method of claim 9, further comprising appending the differential
2 information to the frame data.

1 11. An apparatus comprising:
2 a collector configured to collect video information to be associated with video
3 data gathered from a video source; and
4 an annotator coupled to the collector, the annotator configured to annotate the
5 video data with the video information.

1 12. The apparatus of claim 11, wherein the video information comprises one
2 or more of: camera geometry; camera pose information; and source
3 identification/description/illumination information.

1 13. The apparatus of claim 12, further comprising calibration software
2 configured to generate the camera geometry information for the video data as the video
3 data is being gathered by the video source and provide the generated camera geometry
4 information to the collector.

1 14. The apparatus of claim 12, further comprising pose estimation software
2 and configured to generate the camera pose information for the video data as the video
3 data is being gathered by the video source and provide the generated camera pose
4 information to the collector.

1 15. The apparatus of claim 12, further comprising an encoder configured to
2 encode the video data and generate frame data as an input to the annotator.

1 16. The apparatus of claim 15, wherein the encoder forwards a current state of
2 the frame data to a state storage device coupled to the encoder.

1 17. The apparatus of claim 16, further comprising a comparator configured to
2 compare the current state with the video information of the frame data.

1 18. The apparatus of claim 17, further comprising a differential information
2 generator coupled to the state storage device, the comparator and the encoder and
3 configured to generate differential information from the result of the comparison
4 performed by the comparator and forward the differential information to the encoder.

1 19. A computer readable media containing executable computer program
2 instructions which when executed on a digital processing system causes the system to
3 perform a method comprising:
4 accepting video data from a video source; and
5 storing video information for the video data as the video data is accepted, the
6 video information being stored as annotation to the video data for later use.

1 20. The computer readable media of claim 19, wherein the video information
2 is camera geometry information.

1 21. The computer readable media of claim 19, wherein the video information
2 is camera pose information.

1 22. The computer readable media of claim 19, wherein the video information
2 is source identification/description/illumination information.

1 23. The computer readable media of claim 19, wherein the video data is a
2 frame data obtained from an encoder.

1 24. The computer readable media of claim 19, wherein the video source is a
2 video capture device.

1 25. The computer readable media of claim 19, further comprising gathering
2 current state of the frame data.

1 26. The computer readable media of claim 25, further comprising comparing
2 the current state with the camera geometry information, the camera pose information and
3 the source information of the frame data.

1 27. The computer readable media of claim 26, further comprising determining
2 differential information from result of the comparing.

ABSTRACT

A method and apparatus are provided for annotating video and audio media with supplementary content for post video processing. The method includes the steps of accepting video data from a video source and storing video information associated with the video data as the video data is being accepted. Then, the video information may be appended to the video data for later use in the form of annotations, for example.

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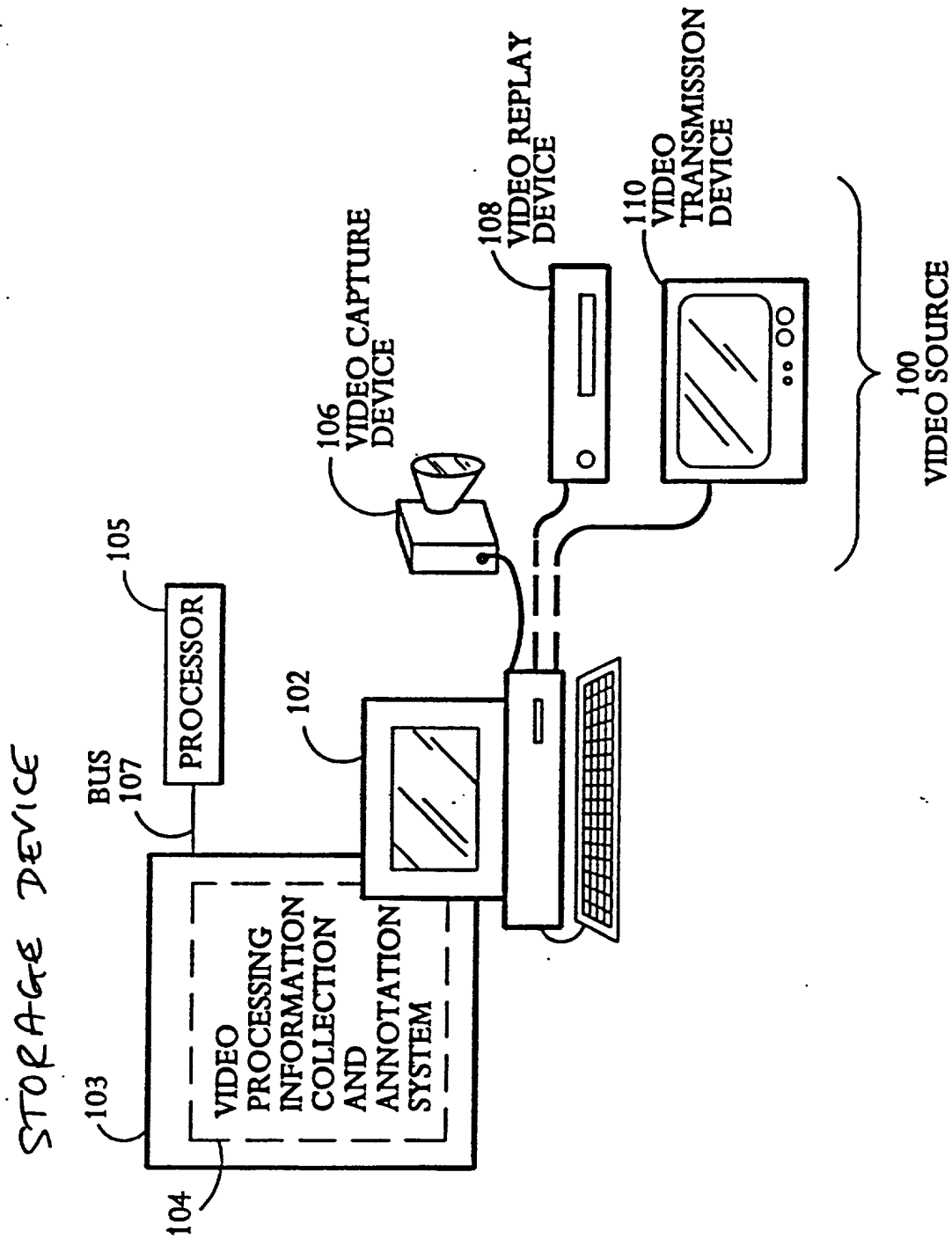


Fig. 1A

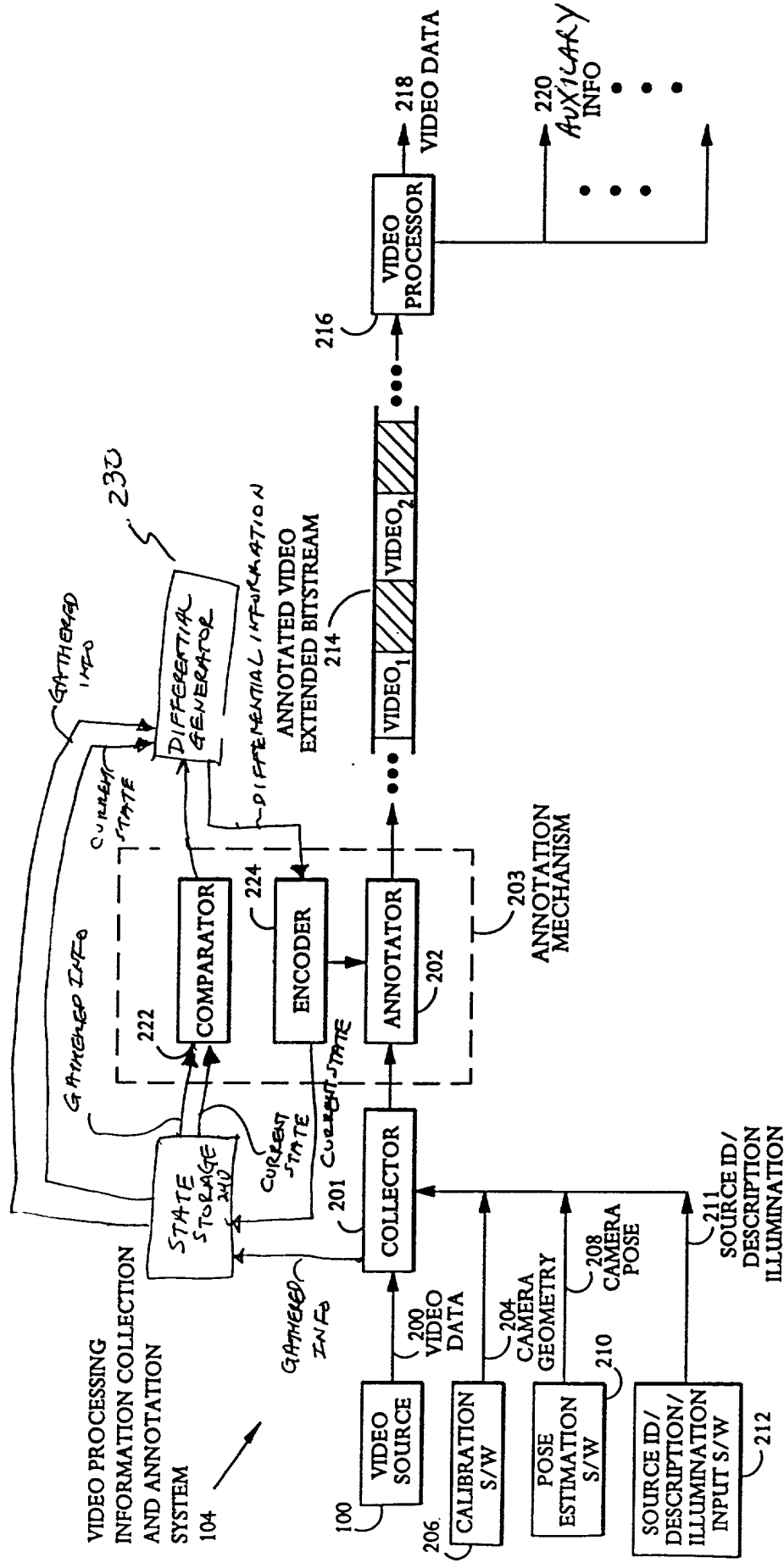


Fig. 1B

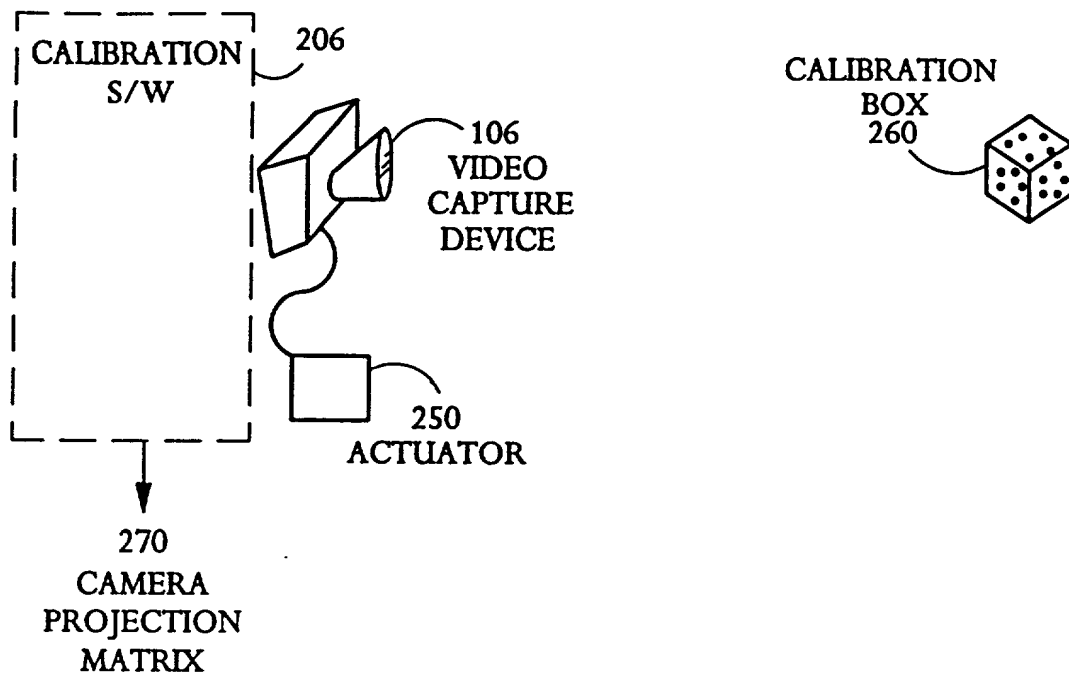


Fig. 2

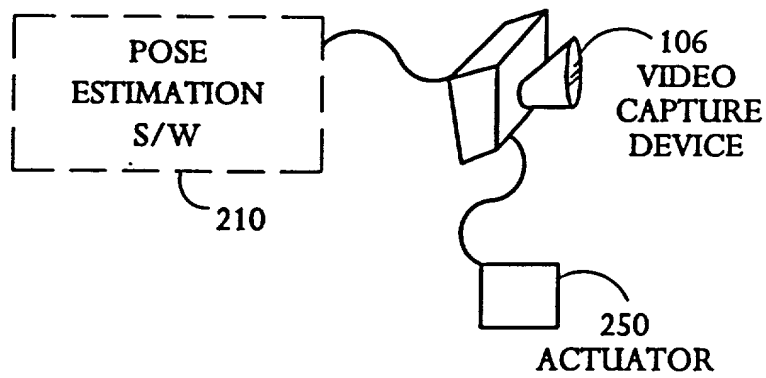


Fig. 3

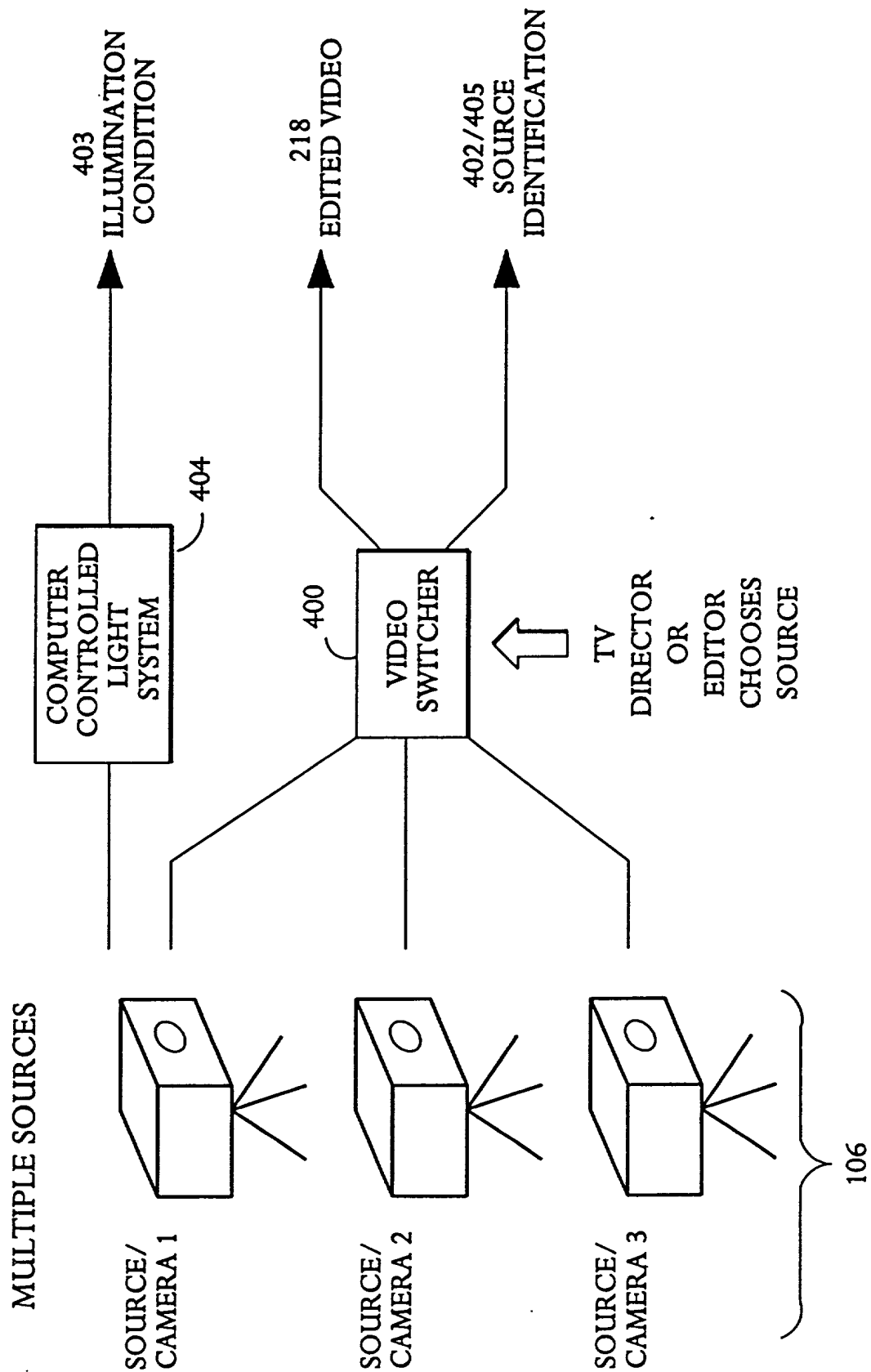


Fig. 4

ANNOTATED VIDEO
EXTENDED BITSTREAM
500

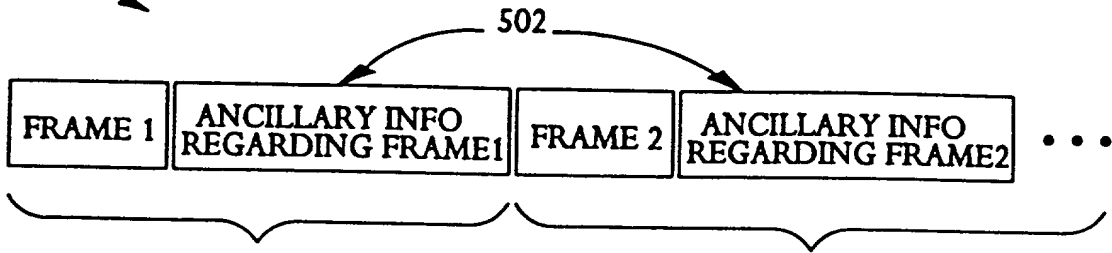


Fig. 5A

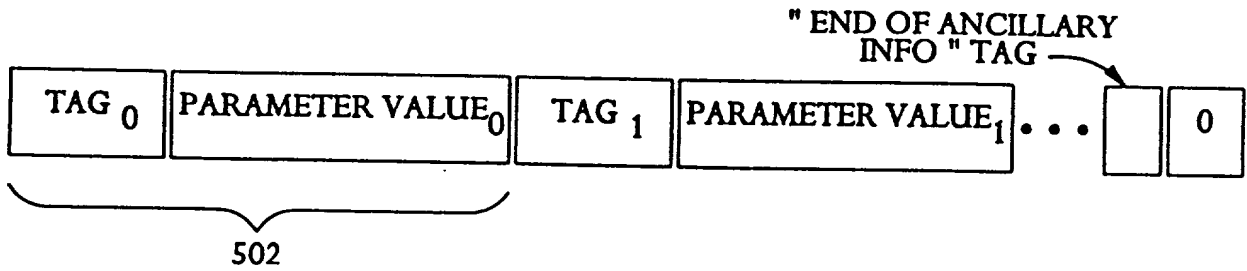


Fig. 5B

TAG
LOOKUP
TABLE
503

TAG ₁	POSE PARAMETER ₁
	•
	•
	•
TAG ₁₂	POSE PARAMETER ₁₂

" END OF ANCILLARY INFO "

Fig. 5C

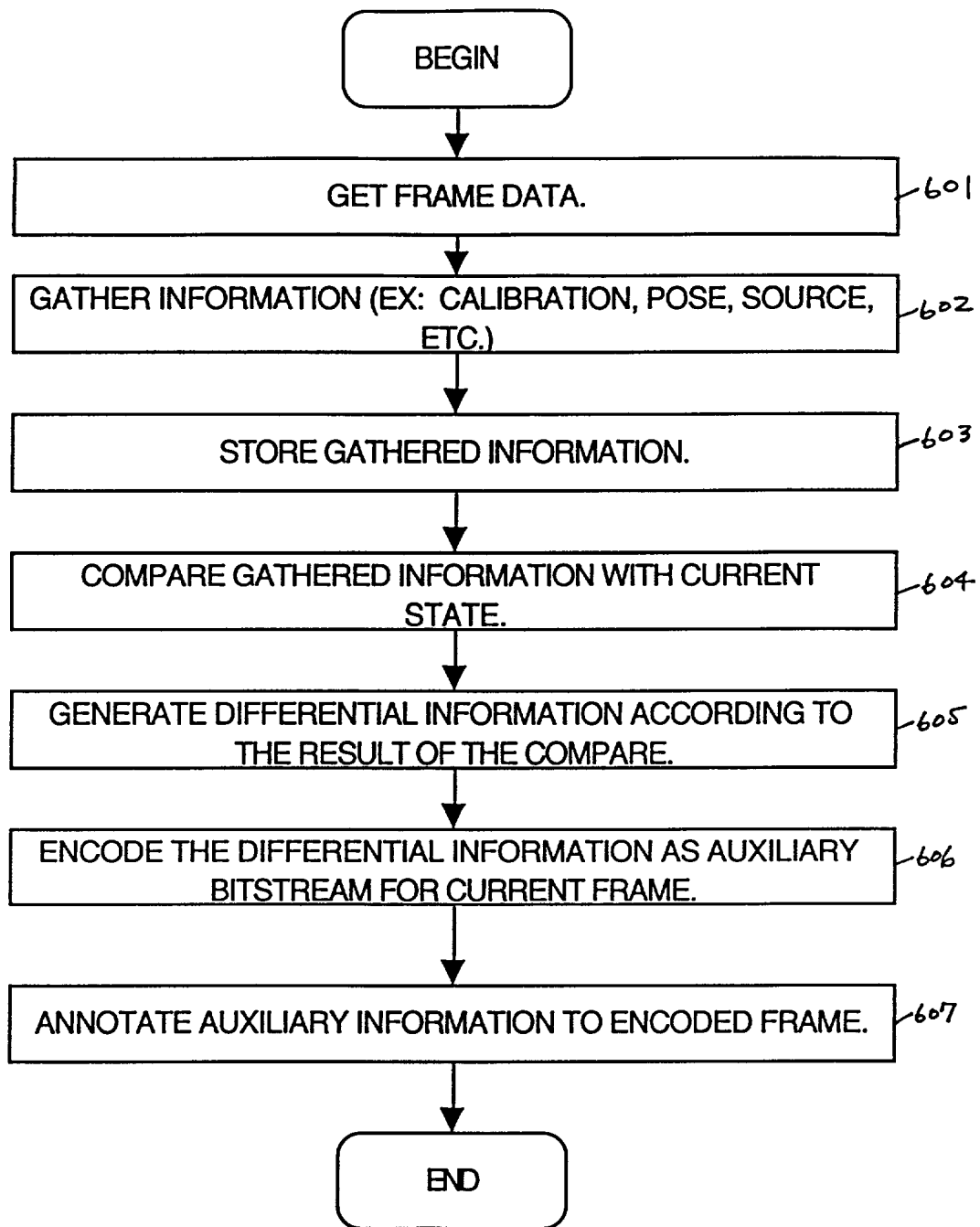


FIG. 6

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

VIDEO BIT STREAM EXTENSION WITH SUPPLEMENTARY CONTENT INFORMATION TO AID IN SUBSEQUENT VIDEO PROCESSING

the specification of which

X is attached hereto.
____ was filed on _____ as
United States Application Number _____
or PCT International Application Number _____
and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

Priority
Claimed

(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No

I hereby claim the benefit under title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below

(Application Number)

Filing Date

(Application Number)

Filing Date

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Number)

Filing Date

(Status -- patented,
pending, abandoned)

(Application Number)

Filing Date

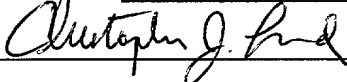
(Status -- patented,
pending, abandoned)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

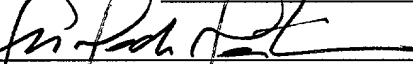
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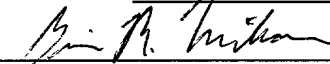
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Title 37, Code of Federal Regulations, Section 1.56
Duty to Disclose Information Material to Patentability

(a) A patent by its very nature is affected with a public interest. The public interest is best served, and the most effective patent examination occurs when, at the time an application is being examined, the Office is aware of and evaluates the teachings of all information material to patentability. Each individual associated with the filing and prosecution of a patent application has a duty of candor and good faith in dealing with the Office, which includes a duty to disclose to the Office all information known to that individual to be material to patentability as defined in this section. The duty to disclose information exists with respect to each pending claim until the claim is cancelled or withdrawn from consideration, or the application becomes abandoned. Information material to the patentability of a claim that is cancelled or withdrawn from consideration need not be submitted if the information is not material to the patentability of any claim remaining under consideration in the application. There is no duty to submit information which is not material to the patentability of any existing claim. The duty to disclose all information known to be material to patentability is deemed to be satisfied if all information known to be material to patentability of any claim issued in a patent was cited by the Office or submitted to the Office in the manner prescribed by §§1.97(b)-(d) and 1.98. However, no patent will be granted on an application in connection with which fraud on the Office was practiced or attempted or the duty of disclosure was violated through bad faith or intentional misconduct. The Office encourages applicants to carefully examine:

(1) Prior art cited in search reports of a foreign patent office in a counterpart application, and

(2) The closest information over which individuals associated with the filing or prosecution of a patent application believe any pending claim patentably defines, to make sure that any material information contained therein is disclosed to the Office.

(b) Under this section, information is material to patentability when it is not cumulative to information already of record or being made of record in the application, and

(1) It establishes, by itself or in combination with other information, a prima facie case of unpatentability of a claim; or

(2) It refutes, or is inconsistent with, a position the applicant takes in:

(i) Opposing an argument of unpatentability relied on by the Office, or

(ii) Asserting an argument of patentability.

A prima facie case of unpatentability is established when the information compels a conclusion that a claim is unpatentable under the preponderance of evidence, burden-of-proof standard, giving each term in the claim its broadest reasonable construction consistent with the specification, and before any consideration is given to evidence which may be submitted in an attempt to establish a contrary conclusion of patentability.

(c) Individuals associated with the filing or prosecution of a patent application within the meaning of this section are:

(1) Each inventor named in the application;

(2) Each attorney or agent who prepares or prosecutes the application; and

(3) Every other person who is substantively involved in the preparation or prosecution of the application and who is associated with the inventor, with the assignee or with anyone to whom there is an obligation to assign the application.

(d) Individuals other than the attorney, agent or inventor may comply with this section by disclosing information to the attorney, agent, or inventor.